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Quantitative increases in temporal lobe symptoms in human males are proportional to postnatal geomagnetic activity: verification by canonical correlation

Kari Anne Hodge and Michael A. Persinger

Behavioral Neuroscience Laboratory, Department of Psychology, Laurentian University, Sudbury, Ont (Canada)

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Enhanced geomagnetic activity during episodes of biochemical stress has been correlated with inferences of increased lability within deep temporal lobe structures Because adult limbic epilepsy is frequently associated with perinatal hypoxia or metabolic disruption within this region, a weak positive correlation was expected between possible signs of mesiobasal temporal lobe lability in normal adults and perinatal geomagnetic activity Canonical correlation demonstrated that young adult males ($n = 243$) displayed a positive ($r = 0$ 31) relationship between the intensity of geomagnetic disturbance the day after birth only and a history of subjective depersonalization, anomalous visual and olfactory experiences The effect was very clear when aa values exceeded 30 nT (gamma). Temporal lobe signs for these males were similar to those reported by normal young adult females ($n = 313$) who did not display any consistent correlation between these measures and perinatal geomagnetic disturbance The results suggest that interactions between perinatal neurochemistry and the correlates of geomagnetic activity might permanently alter portions of the male limbic system

Parturition is considered a significant event that can permanently affect the electrical lability and neuronal microcircuitry of the human brain. Brief periods of perinatal hypoxia or metabolic disruptions have been considered a major contribution to the development of adult temporal lobe epilepsy [28]. Adult neuropathology has indicated that a primary focus of changes within the perinatal brain is the electrically labile, neuroplastic structures of the mesiobasal temporal lobes. the amygdala and hippocampus [4]

In the adult these limbic structures may be sensitive to increased geomagnetic activity Daily enhancements of more than 20 nT (gamma) have been associated with decreased seizure thresholds [9, 27] and an increased incidence of bereavement hallucinations [22]; the latter phenomena was considered an interaction between stress-induced elevations of ACTH-corticosteroids [31] and nocturnal melatonin disruptions. Subjects exposed for less than an hour to magnetic fields of slightly higher frequency (> 0.5 Hz) and larger intensity (50–100 nT) have displayed changes in electroencephalographic [33] and subjective experiences [30] that are commensurate with stimulation of deep mesiobasal structures Adult anxiety levels, a non-specific inference of limbic activity has been associated with geomagnetic activity around the time of birth by two groups of investigators [18, 23].

Increased agitation of the perinatal magnetic environment has been associated with permanent changes in the behavior of rodents [19, 20]; brief exposures are more effective than continuous applications [15] and males may be more vulnerable than females [15, 19] The general consequences involve the behavioral domain of enhanced emotional responsiveness to sensory input [25] These changes may be the rodent equivalent of the sensory limbic hyperconnectionism that has been postulated by Bear [2] as the major microstructural factor in the generation of interictal limbic behaviors in human beings. Synaptic ultrastructure, at least in the rat pineal organ (for which experimental evidence of magnetic field sensitivity has been determined [32]), displays quantitative changes during geomagnetic storms [1].

Psychometric evidence collected by Persinger and Makarec [24] and clinical observation by Neppe [17] suggest the existence of a continuum of temporal lobe lability within the human population. Normal people, without a history of seizure, have been shown to report experiences and to display behaviors that are qualitatively similar but less extreme and persistent than patients with electrical foci in the mesiobasal structures. People with elevated numbers of temporal lobe signs and symp-

Correspondence M A Persinger, Behavioral Neuroscience Laboratory, Laurentian University, Sudbury, Ont., P3E 2C6 Canada

toms show consistent personality patterns, enhanced mystical experiences and exotic beliefs [21]

We reasoned the following: (1) if enhanced geomagnetic activity affects limbic lability during periods of biochemical distress, (2) perinatal disruptions can produce long-term changes in specific domains of behavior that are highly correlated with the amygdala and hippocampus, and (3) there is a continuum of temporal lobe lability, then there should be positive correlations between the numbers of temporal lobe signs and symptoms in the normal population and the intensity of the geomagnetic disturbance on the day of birth If the neurochemical sensitivity of the human neonate is comparable to that of other mammals, then the effects should also be more evident for males than for females This prediction was based upon the selective sensitivity of male rats to perinatal magnetic fields. Because only two hours exposure to the normal elevation of testicular testosterone is sufficient to affect adult behavior, we reasoned that disruptions in this system during these critical features could also produce long-term, subtle changes.

To test these hypotheses, the PPI (Personal Philosophy Inventory) data dor *all* male ($n=243$) and female ($n=313$) subjects who were born between 1961 and 1969 were obtained from our central data base All subjects had been university students who were enrolled in first or second year psychology courses at the time of testing; the PPI data were collected over a 10-year period

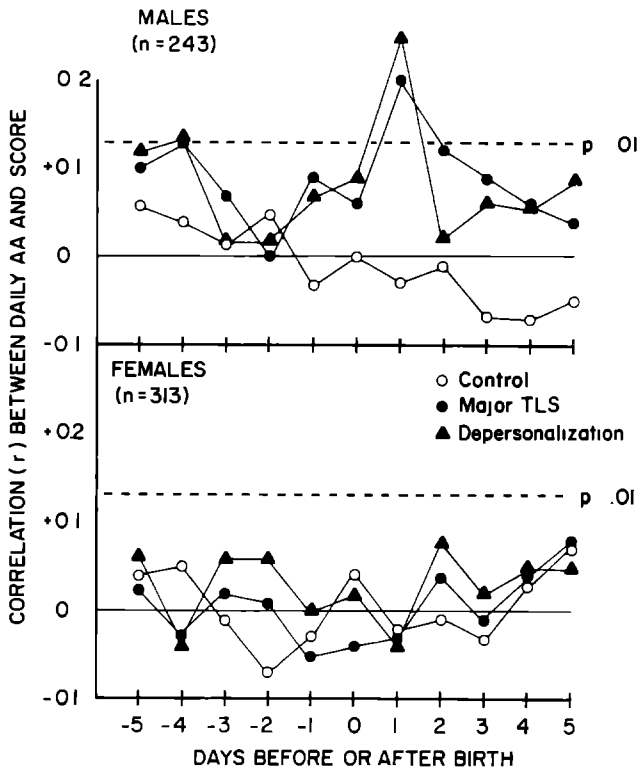

Fig 1 Correlation coefficients (r) between clusters of control items and items that infer temporal lobe signs and symptoms in normal young men ($n=243$) and women ($n=313$) and perinatal geomagnetic activity The TLS scale represents the general cluster of signs and symptoms while depersonalization refers to only specific types of adult experiences

The primary clusters of items constituted the control ($n=16$), complex partial epileptic signs [24] or CPES ($n=16$) and temporal lobe signs [12] or TLS ($n=30$) scales, these items have been published elsewhere. The CPES cluster contains items that reflect experiences that are similar to those reported during the ictal states of complex partial epileptic or limbic seizures while the TLS cluster contains items that include these items and reference to classical interictal-like behaviors

Subclusters, intended to identify specific domains included: fear, writing, meaningfulness, visual sensations, depersonalization, auditory-vestibular effects, subjective psi experiences and a sense of presence (example items are given in reference). The daily aa (average antipodal) index (published in tabular form [14]) was used as the measure (in nT) of global geomagnetic activity. (aa values are based upon quantitative measures of 3-h magnetogram measurements from a northern and a southern hemispheric station; the values are highly correlated (>0 95) with other geomagnetic indices that involve larger numbers of stations.) For each subject the daily values for the 7 days before, the day of and 7 days after the day of birth were determined To accommodate skewness within the geomagnetic data, log (base 10) values were calculated for the daily aa values. All analyses were completed by SPSSX software on a Vax 4000 computer

Fig. 1 shows the zero order bivariate correlations between the geomagnetic activity during the perinatal period and the numbers of reported temporal lobe signs and symptoms for males and females. Only males displayed consistent, statistically significant effects; consequently all further analyses and discussion will involve this gender They showed differentially significant correlations (r values in parentheses) between the geomagnetic activity the day after birth and the numbers of temporal lobe signs as measured by the CPES (0.18) and TLS (0 20) scales but not with the numbers of items of the scale that was a control for yes responding (-0.03) The effect was still significant when the first and second half of the population of males were analyzed separately For example, the correlations between the CPES and the geomagnetic activity the day after birth were 0.17 and 0.19, respectively

In order to minimize artifacts from variations in monthly average geomagnetic activity partial correlation analyses were completed with these variables after the variance associated with the mean aa value for the

month in which the subject had been born was removed The correlation between geomagnetic activity the day after birth and each of the cluster scores were: control (−0.03), CPES (0.17), and TLS (0.18). For the subclusters, only depersonalization (0.23), a sense of presence (0.11), anomalous visual sensations (0.14) olfactory (0.14) and psi (0.18) experiences were significantly correlated with geomagnetic activity the day after birth; the other clusters: fear (0.09), writing (−0.06), meaning (0 05), and auditory-vestibular (0.07) were not.

Canonical correlation between the (log base 10) of the aa values for. (1) the day after birth and for each of the two days before and after that day and (2) the 8 subclusters of temporal lobe signs revealed one major root (canonical correlation = 0.31). It was loaded only (i.e , $r > 0.40$) by the geomagnetic activity the day after birth (0 87) and by the visual (0 59), depersonalization (0.90), psi (0.67) and olfactory (0.45) clusters. Separate factor analyses of the 9 subclusters verified the shared variance of these 4 subclusters (eigen value = 2 79; 35% explained variance). To determine the advantage of the canonical technique for estimates of maximum variance and the specificity of the day after birth, multiple regression analyses were completed for each of the geomagnetic activity for each of the five days (separately as dependent variables) with the 8 subclusters as independent variables. Only the equation for the day after birth was significant with only one variable, depersonalization ($r = 0.23$) entering the equation ($F_{1,241} = 15.26$, $P = 0\ 0001$)

To determine if the temporal lobe signs among males reflected a linear trend or 'threshold' relationship with geomagnetic activity, daily aa values (in nT) for the day after birth were partitioned into 5 groups ($n = 49$–52 per group). 0–8, 9–13, 14–19, 20–29 and 30 through highest value Polynomial analyses (all dfs = 1,238) containing tests for linear, quadratic and cubic trends, revealed only linear relationships between the five geomagnetic activity intervals and the scores (all Fs between 4.67 and 14.42, $P < 0.01$) for the CPES, TLS major clusters and the psi, depersonalization, sense of presence and visual subclusters.

One-way analyses of variance (all dfs = 4,238) with post hoc tests (Tukey, $P < 0.05$) also revealed significant group differences, primarily between males where the first postnatal days were below 9 nT and above 30 nT, for the TLS scale ($F = 3\ 06$, $P = 0.01$) and depersonalization ($F = 3.92$, $P < 0\ 01$). The source of the difference for the olfactory experiences was between the groups born below 30 nT and equal to or above this value ($F = 3\ 17$, $P = < 0.01$). The other scales, including the control cluster ($F_{4,238} = 1.11$, $P > 0.05$) were not significant.

To test for the specificity of the effect for the day after birth, Pearson correlations were completed between the scales and with the largest single daily aa value during the first 3 days after birth; the absolute values of the correlation coefficients did not change by more than 0.02, e g., 0.17–0.19 To insure that the correlations were not due to montly or seasonal artifacts in geomagnetic activity one-way analyses of variance was completed for each of the scales as a function of the month of birth ($n = 17$–29/month); there were no statistically significant ($F_{11,231} = < 1.00$, $P > 0.05$) differences between the cluster scores as a function of month of birth. Multivariate analyses of variance (MANOVA) for both the log (base 10) values of the daily aa measures and the absolute measures for the day of birth and for the two days before and after birth (5 days) revealed no significant differences ($F_{4,968} < 1$), consequently birth days were not associated with higher geomagnetic activity. The mean and standard deviation for the aa values for the 5 day perinatal periods was 21.3 (16.6) nT.

Perinatal or umbilical levels of androgens have been associated with later spatial ability and mood in children; the correlations for males are often opposite to those of females [5, 6] The results of the present study suggest that there is an elevation of a specific hormonal factor during the day after parturition in males but not females that interacts with the neurochemical correlates of enhanced daily geomagnetic activity, the effect occurs in a 'dose-dependent' manner but is particularly evident when the daily aa value exceeds 30 nT. The interaction contributes later to enhanced numbers of temporal lobe signs that are similar in magnitude to normal females and suggests a mild reduction in the sexual dimorphism in limbic structures. Interestingly, the males who had the highest (upper 25%) scores on the subclusters that were loaded on the major canonical root also displayed significantly higher ($F = 5.95$, $P < 0\ 001$) feminine scores on a cluster of 10 (different) items from the PPI that maxi-

TABLE I

SAMPLE ITEMS FROM SPECIFIC SUBCLUSTERS OF THE TEMPORAL LOBE SENSITIVITY (TLS) SCALE FROM THE PERSONAL PHILOSOPHY INVENTORY (PPI)

Fear I am afraid of earthquakes
Writing After writing prose or poetry, I feel better
Meaningfulness I have had a religious experience that I know was real
Visual experience There have been times when I have stared at an object and it appeared to become larger and larger
Depersonalization: I often feel if things are not real
Auditory-vestibular sensations: While sitting quietly, I have had uplifting sensations as if I were driving over a rolling road
Subjective Psi experiences An inner voice has told me where to find something and it was actually there
Presence At least once in my life, very late at night, I have felt the presence of another Being

mally discriminate normal male and female university students.

In rats, attenuation of the rapid increase in serum testosterone that peaks within hours after birth prevents masculinized adult behaviors such as mounting [29], reduces the volume of the sexually dimorphic preoptic nucleus of the hypothalamus [16, 29] and alters the estrogen-binding receptors in the amygdala. We hypothesize that geomagnetic field disturbances statistically open membrane Ca^{2+} channels [8, 10, 11, 15]. The subsequent quantitative increase in intracellular Ca^{2+} reduces the amount of testosterone (by enhancing catabolizing enzymes or disrupting a calmodulin-testosterone transport system) that is normally sequestered by chromatin (DNA)-related receptors on the cell nucleus during the critical perinatal period. The results are permanent alterations in the relative numbers of estrogen-binding receptors on amygdaloid and preoptic [26] neurons and enhanced epilepticity in CA1 hippocampal neurons [7].

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